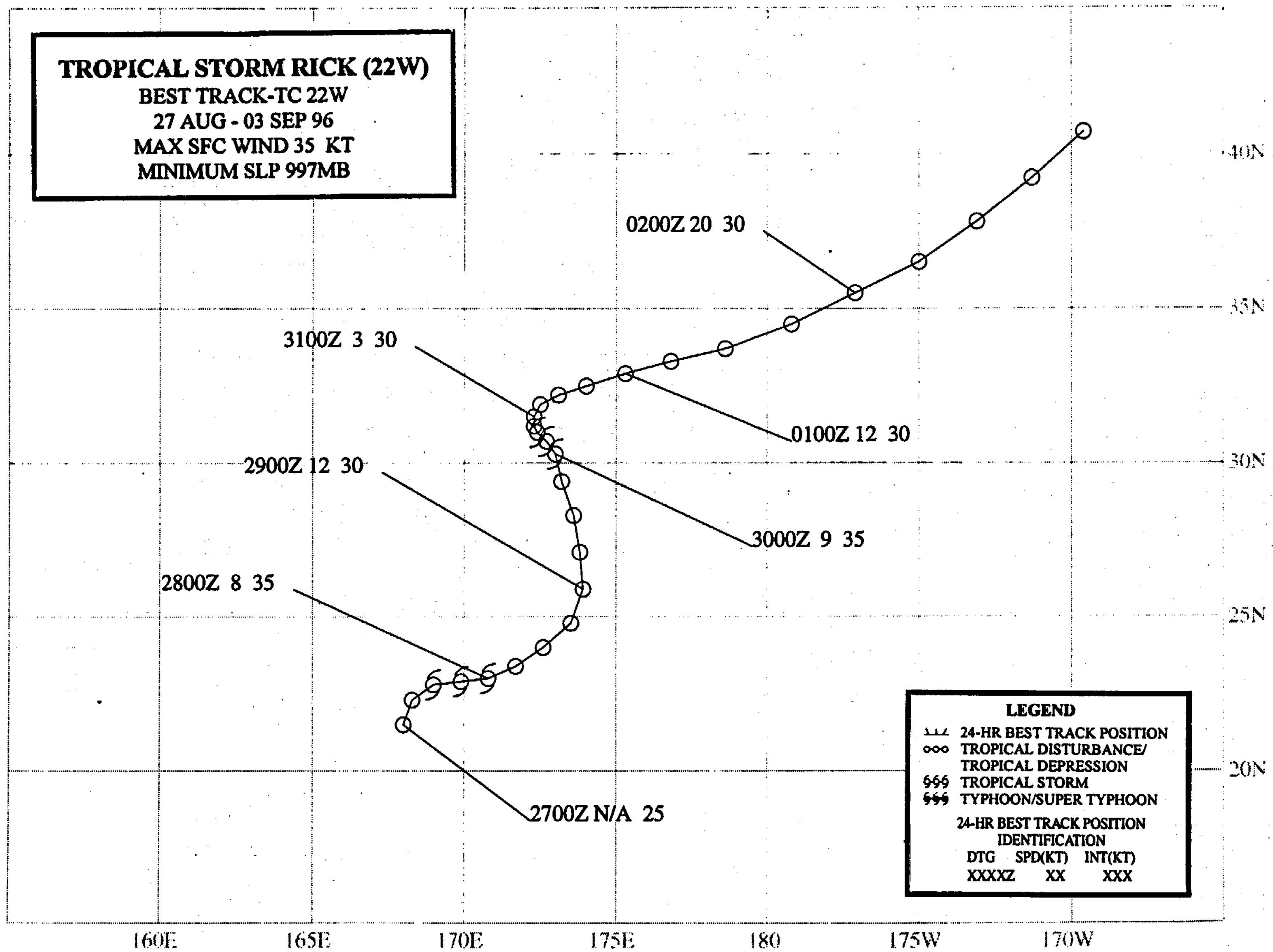
TROPICAL STORM RICK (22W)
BEST TRACK-TC 22W
27 AUG - 03 SEP 96
MAX SFC WIND 35 KT
MINIMUM SLP 997MB
0200Z 20 30
3100Z 3 30
0100Z 12 30
2900Z 12 30
3000Z 9 35
2800Z 8 35
2700Z N/A 25
40N
35N
30N
25N
20N
160E
165E
170E
175E
180
175W
170W
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XXX

I. HIGHLIGHTS

Rick formed at a high latitude at the end of a northward-displaced monsoon trough. The first warning was issued without a prior Tropical Cyclone Formation Alert when scatterometer data indicated the well-defined low-level circulation possessed winds of at least 30 kt (15 m/sec).

II. TRACK AND INTENSITY

During the last week of August, the axis of the monsoon trough was displaced well to the north of its normal location. Anchored at 25°N by the slow-moving Orson (19W), the axis of the monsoon trough extended east-northeastward toward the international date line. Prior to Rick's formation, two other TCs — Typhoon Piper (20W) and Tropical Depression 21W — formed at the end of this monsoon trough and moved on poleward-oriented "S"-shaped tracks.

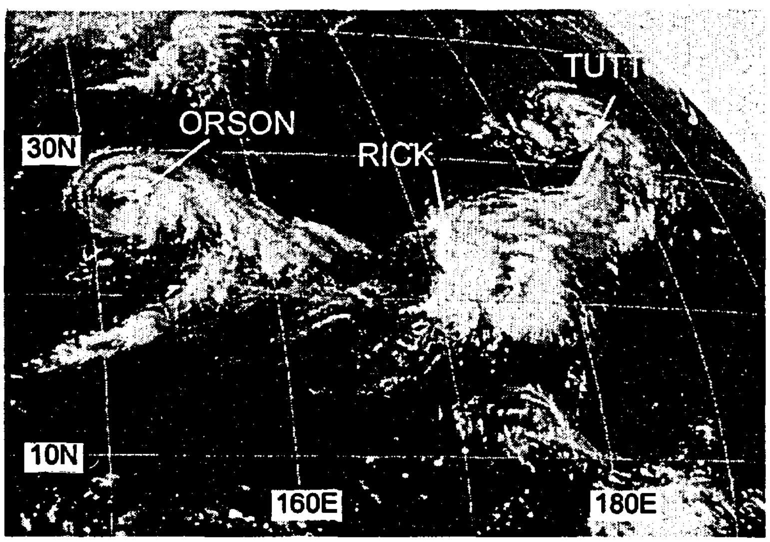

Figure 3-22-1 The tropical disturbance that became Rick is located between Orson (19W) and a TUTT cell. Scatterometer data at this time showed that it was already at tropical-storm intensity, and the final best track was adjusted accordingly (272130Z August infrared GMS imagery).

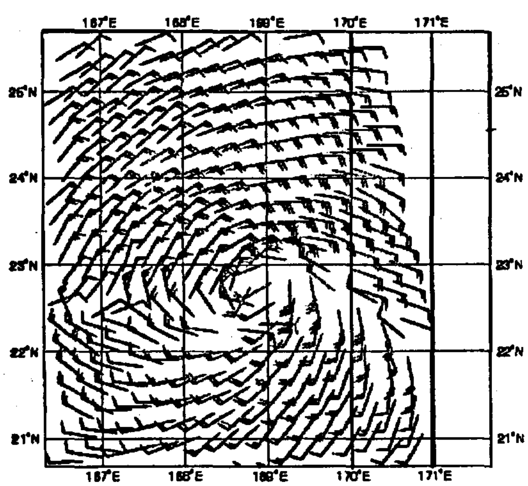

Figure 3-22-2 A well-defined LLCC with maximum winds of 30 kt accompanies "Rick's" cloud system at the time of the image in figure 3-22-1 (272110Z August ERS-2 scatterometer-derived winds).

The tropical disturbance which became Rick was located between Orson (19W) and a well-defined TUTT cell (Figure 3-22-1). This disturbance was first mentioned on the 260600Z August Significant Tropical Weather Advisory when synoptic data indicated that it was accompanied by a weak LLCC. When a scatterometer pass at 271121Z (Figure 3-22-2) revealed that a well-defined LLCC (with maximum winds of 30 kt) accompanied the poorly-organized cloud system shown in Figure 3-22-1, the JTWC issued the first warning (valid at 280000Z) on Tropical Depression (TD) 22W. In post analysis, the scatterometer pass was used to upgrade TD 22W to tropical-storm intensity at an earlier time than upgraded while in warning status.

Initially moving northeastward along the axis of the monsoon trough, TD 22W turned to the north when it approached a blocking high. After crossing 30°N, TD 22W slowed and its cloud pattern became better defined (Figure 3-22-3, see also Figure 3-21-1 in the summary of TD 21W). Better cloud organization and satellite-based microwave data (SSM/I) indicating 35 kt (18 m/sec)

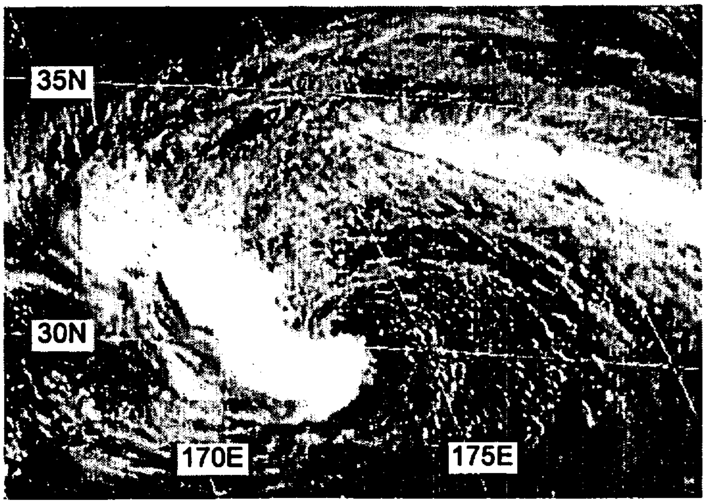

Figure 3-22-3 The primary band of deep convection coils around the western side of Rick's partially exposed LLCC (292131Z August visible GMS imagery).

prompted the JTWC to upgrade TD 22W to Tropical Storm Rick on the warning valid at 300000Z. On the warning valid at 301200Z, the system was downgraded to a tropical depression when the amount of its central deep convection decreased.

On 31 August, the system entered the accelerating westerlies regime north of the subtropical ridge. While Rick was moving east-northeastward at the base of an advancing frontal cloud band, its final warning was issued valid at 311200Z. The remnants of Rick continued to sweep northeastward within the frontal cloud band. The final best track carries the system across the international date line and north of 40°N.

III. DISCUSSION

a. *High latitude of formation*

Tropical cyclogenesis (TC genesis) is relatively rare east of 160°E and north of 20°N in the WNP. There are two synoptic conditions that lead to most of the TC genesis there: (1) TUTT-induced TC genesis, and (2) TC genesis that occurs when the monsoon trough has penetrated unusually far to the north and east. In Rick's case, the monsoon trough had migrated to an unusually high latitude, and the disturbance that became Rick formed at the eastern end of this trough. There was also a large well-defined TUTT cell northeast of this disturbance (Figure 3-22-1), but its role (if any) in Rick's development is not clear.

b. *Scatterometer data*

The first warning on Rick was based upon scatterometer data from the European Remote Sensing Satellite-2 (ERS-2) (Figure 3-22-2). The JTWC has access to scatterometer wind data, and has used it to help determine the position, intensity and wind distribution of TCs for nearly one and a half years. Some drawbacks of the scatterometer data are its small swath width, 180° directional ambiguity, relatively coarse resolution, limitations on the wind speeds it can accurately detect, and a low-speed bias.

The scatterometer pass which prompted the first warning on TD 22W (Figure 3-22-2) contains many 25-kt (13-m/sec) wind reports, with a maximum report of 30 kt (15 m/sec) just east of the system center. In real time, this was used to support a warning intensity of 30 kt, but, in post analysis was used to upgrade TD 22W to tropical-storm intensity at an earlier time. When compared with buoys and ship reports, the scatterometer winds generally have a low-speed bias (Quilfen, 1992; Laing, 1994; and Laing and Brenstrum, 1996). Laing and Brenstrum (1996) showed that the ERS-1 winds had a mean low-speed bias of about 4 kt (2 m/sec) when compared with the winds recorded on a New Zealand research ship (Figure 3-22-4). The magnitude of this bias increases with increasing wind speed. The low-speed bias increases to near 6 kt (3 m/sec) at wind speeds of 30 kt (15 m/sec). In operational practice, the JTWC treats a 30-kt scatterometer wind as representative of a 35-kt one-minute average 10-m wind. Hence, the 30-kt maximum scatterometer wind in Figure 3-22-2 was used in post analysis as grounds for upgrading the intensity of TD 22W from 30 kt to 35 kt (i.e., from a tropical depression to a tropical storm).

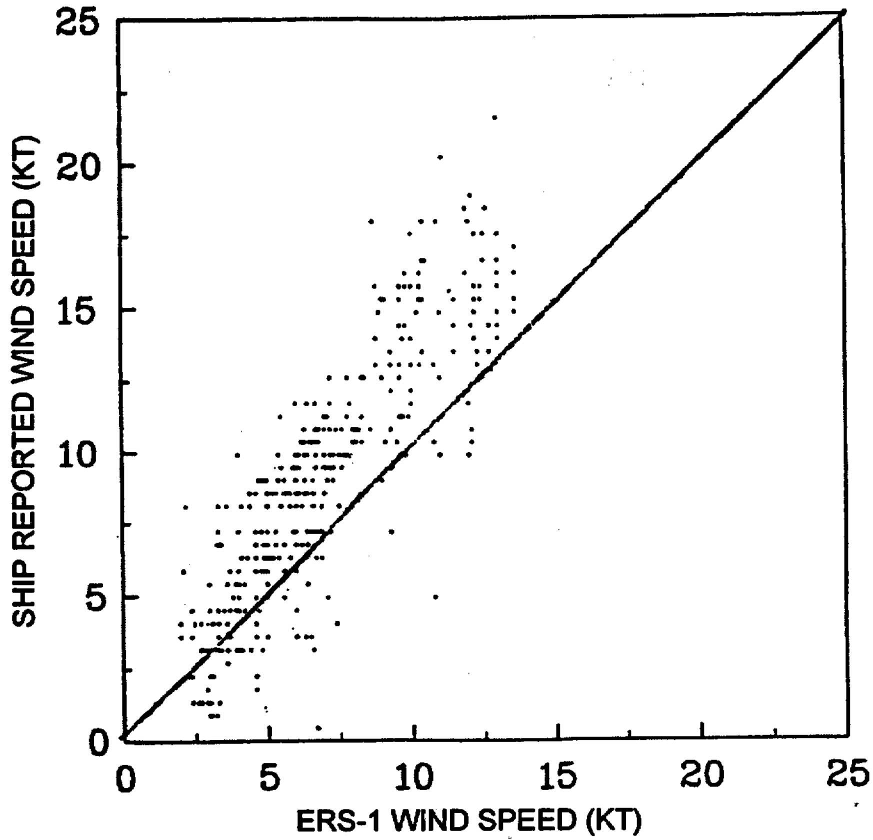

Figure 3-22-4 A comparison of the wind speeds recorded by the New Zealand research ship Tangaroa with wind speeds obtained from the ERS-1 scatterometer. That most of the points are above the 45° line indicate that the ship wind speeds are generally higher than those estimated by the scatterometer. (Figure adapted from Figure 2 of Laing and Brenstrum (1996).)

IV. IMPACT

No reports of damage or injury were received at the JTWC.